Redefining Literacy Learning About Learning to Read: A Conversation with Sally Shaywitz and Marcia D'Arcangelo

Unlike speaking, reading is not an instinctive human ability. New imaging techniques now allow researchers to see how our neurocircuitry uses the brain's language system to both speak and read. Neuroscientist and professor of pediatrics at Yale University School of Medicine, Sally Shaywitz, along with her husband, Bennett Shaywitz, is codirector of the Yale Center for the Study of Learning and Attention. For 30 years, she has focused on understanding the brain mechanisms involved in reading. While developing "The Brain and Reading" video series, Marcia D'Arcangelo interviewed Dr. Shaywitz about her life's work. We hear how advances in brain imaging technology let us see the brain at work. Because we wonder whether new discoveries can inform our instructional practice, learning about how the brain works is of great interest to educators today. Educators have always been interested in the brain, but we scientists haven't had the ability to bring issues relating to the brain to education. But now, we can actually look at the working brain and examine what happens when a child tries to learn. These matters are very germane to what teachers need to know.

What do we really know about how the brain learns to read?

We know that whereas speaking is natural, reading is not. Children do not automatically read. They have to learn how to do it. Through tens of thousands of years of evolution, men and women have developed the abilities to speak, to hear, and to listen. Every society has some form of spoken language. Put a baby in a speaking environment and that child will learn to speak. We don't have to teach children how to talk. As Stephen Pinker says, language is instinctive. But reading isn't. Reading is a recent development. Not every society reads. There isn't a little reading center in the brain. Humans haven't evolved that way. The neurocircuitry isn't set up to allow us to read. But humans do have the capacity to read. Over time, we have learned to use our neurocircuitry to read. The brain system that lends itself to reading is the language system. To read, a child has to use this wonderful, enriched, and robust language system to somehow get meaning from print. To do that, a child has to somehow transcode that print into language.

Are you saying that in order to read, we have to adapt, or train, our brain to perform in ways it wasn't naturally designed to work?

In essence, yes. We acquire the ability to do many things that we aren't born knowing how to do. Children have to develop the awareness that words are made up of sounds. And that print represents these sounds,or phonemes. For example, the word bat really has three phonemes, b, a, and t, so children have to develop this awareness. And then they have to develop the understanding that the letters on the page——the b, the a, and the t——represent these units of sound. When children reach this level of awareness, they're ready to learn to read. For some children, it's easy; for others, it's very difficult.

You and your group at Yale have used functional magnetic resonance imaging (fMRI) technology to analyze how the brain learns to read. Have you discovered why it is easy for some and difficult for others?

In one study, we examined very disabled readers and compared them with good readers. We found a difference in the brain activation patterns of the two groups when the task made increasing demands to break up words into their underlying phonologic structure or sound pattern. This is very exciting and extraordinarily important. One, it shows the functional organization of the brain for reading. Two, it shows what happens when people have trouble reading. And three, it shows when the problem occurs. Knowing all of this supports the view that reading is biologically based and lends substantial support to the phonologic hypothesis of how we read and why some people can't read.

Why is it important to understand that reading is biologically based?

We often blame children, particularly bright children who have trouble reading, for not being motivated enough or for not trying hard enough. As if somehow, it's their fault. But if we have evaluated the children, we know that they're trying hard, more than anyone can imagine. But they have nothing to show for it. Before, we could hypothesize that the child was very bright but had a real biologic difficulty making him or her unable to read. Now, we can look at an imaging pattern and say, "Aha, this is a real problem; this is as real as a broken arm that you might look at on X-ray."

Can we look at brain imaging patterns and tell which children will have trouble reading?

This technology has been an extraordinary advance, but I don't want to mislead people. We can't use it yet to diagnose an individual. Someone cannot get into the scanner and say, "Aha, I have an image, and I can have a diagnosis." But I have no doubt about the potential for this technology to diagnose people early and more precisely and then to actually examine the effects of interventions.

What difference, specifically, did you see in the brain patterns of good and poor readers?

Good readers had a pattern of activation in the back of the brain, the system that includes the occipital region, which is activated by the visual features of the letters; the angular gyrus where print is transcoded into language; and Wernicke's region, the area of the brain that accesses meaning. This posterior area is strongly activated in good readers, but we saw relative under- activation in poor readers. As we asked good readers to do more and more phonologic processing——to look at single letters and tell whether they rhyme and then to look at and sound out words that they had never seen before——we could see an increase in activation in these areas. But when poor readers performed these same phonological tasks, they really didn't increase the activation in the back of the brain. There was a significant difference. What made it even more interesting was that there were differences in the front of the brain as well. When good readers read, an area in the front of the brain called the inferior frontal gyrus, or Broca's area, was activated. When poor readers read, that area was even more strongly activated.

What does this pattern of relative underactivation and overactivation in poor readers tell you?

We've interpreted this to mean that in going from print, from seeing letters, to language——which is the task of reading——poor readers have incredible difficulty. The relative increase in activation in the front of the brain reflects their effort. Sometimes when people can't read, they sub-vocalize. They say the word under their breath. This may represent additional effort to pronounce the word accurately. It's incredible that we found this difference in the angular gyrus, the area that helps transcode one precept——say, the visual——to another, the linguistic. This makes sense given what we know about the cognitive process of reading, going from print to language. Clearly, we have a lot to learn, but now all investigators who have worked hard to understand reading and the brain have a place to focus future research. We can go to the next level of trying to understand the neural mechanisms that lie under reading and reading impairment.

In other words, the brain systems of poor readers process incoming print information differently from the way that the systems of good readers do.

Yes, there really is a difference in brain activation patterns between good and poor readers. We see the difference when people carry out phonologically based tasks. And that tells us that the area of difficulty——the functional disruption——in poor readers relates to phonologic analysis. This suggests that we focus on phonologic awareness when trying to prevent or remediate the difficulty in poor reading.

After poor readers master the reading process, do their brain activation patterns change, or are patterns of activation similar all their lives?

That's an important question that our research group at Yale is collaborating with investigators at Syracuse University (Anita Blachman) to address. Children who are poor readers are receiving a highly focused, phonologically based intervention, and they are imaged both before and after the intervention. We expect to have the results of this study within a few years.

Are the results you discovered with brain imaging consistent with what you find when you study readers cognitively?

They are. For example, a number of years ago we studied more than 300 children, most of whom were poor readers. When we examined these children on a range of tasks, the one that most significantly differentiated good readers from poor readers assessed phonemic awareness. For example, we asked children to say a word and remove a phoneme: "Can you say 'Germany' without 'ma'?" To do that, they have to segment that spoken word and pull out a part. Children who had difficulty with this phonologic processing task were also the poorest readers. One of the strongest predictors of who will be good readers is their phonemic awareness. The evidence we have that this is brain based converges nicely with behavioral information.

What are the implications of these studies for teaching reading?

Pretty strong evidence supports a phonologic model of reading. People have to be aware, clearly, that it's a complex issue. We want children to be able to read the word on the page. But we must also remember that we want them to read the word on the page to get to the meaning and the richness of the literature and the language. But if they don't know how to read the individual words, what can we do? The most comprehensive reading program explicitly teaches about the sounds of language. It teaches children that words can be broken up into these smaller units of language, that the letters represent these units of language——phonics. But we also want to teach children about language and to build their vocabulary. We want them to have a knowledge base. We want them to practice reading and to read for meaning. So we want a balanced program. Although phonics is more important for some children than for others, all children can benefit from being taught directly how to break up spoken words into smaller units and how letters represent sounds.

You mentioned that children must practice reading. What is it about how the brain functions that makes practice important?

Think of brain pathways as circuits. The more we use them, the more they become reinforced. It's very important for children to read often. But if children can't read well, they're not going to want to read. But if we can give poor readers a sound foundation so that they know and can decode a group of words, they will have the phonologic skills to sound out words they've never seen before and will be encouraged to read. Once children know how to decode words, we want them to become fluent and automatic and be able to see words and read them without struggling. Only then will they have the resources left to enjoy what the word means and to think about the multiple meanings of what they're reading.

Can you give an example of how being taught directly about language can be more important for some children than for others?

We get very concerned about poor readers who are dyslexic, who have difficulties in phonology but have strong skills in reasoning, understanding, and comprehending. Their isolated skill in phonology is lacking, but all the other skills and understandings are there. These children often have wonderful vocabularies. Imagine their frustration. They see a word in print but can't read it. Then someone says, "Oh, you don't know that?" But when they hear the word, they know it very well. It is important to identify these children as early as possible and to give them the help they need in the most intense, direct way possible. Back in 1985, *Becoming a Nation of Readers* suggested that teaching phonics is not a useful practice after the early grades. Yet we have many children in the upper grades, including high school, who read poorly.

Do children outgrow the need for direct phonics instruction?

We know that brain systems are plastic, flexible, and responsive, but we have to give children the right substrate in terms of how we teach them. Children who have a biologically based difficulty can learn, but we have to present instruction in a more direct, more intense way over a longer duration. We should also clarify that today's research-based interventions are not our mother's phonics. Today's programs, for example, research-based interventions supported by the National Institute of Child Health and Human Development (NICHD), are balanced, comprehensive programs that include phonologic awareness, phonics, literature, vocabulary, fluency, and comprehension-strategy components.

Have your studies revealed any differences between boys' and girls' ability to learn to read?

We've examined this issue in several ways. We started the Connecticut Longitudinal Study in 1983, when we identified a random group of more than 400 five-year-old boys and girls about to enter kindergarten. We didn't select these children because they had reading problems. The only criterion was that they attended public school in Connecticut. We're still following over 90 percent of these children, who are now in their early 20s. We've tested them in reading and arithmetic every year. When we compare the boys' and the girls' reading scores, we don't see differences. That surprised us because the literature suggests that boys may have more problems. So, for all the children in our study, we asked their schools, "Has this child been identified as having a reading problem?" We found that four times as many boys as girls were identified as having a reading problem. When we examined our data for an explanation, we found that teachers seemed to be using behavioral criteria. They saw that Johnny was a little more fidgety in class, a little more disruptive, so they selected little boys for further evaluation; little girls who were just sitting very nicely, very politely, but not reading, might not be identified.

Recently, haven't you found some brain-based gender differences in the ways that men and women read?

We found something rather remarkable. We examined brain activation patterns in men and women as they were sounding out nonsense words. We gave them two printed nonsense words and asked, "Do these two words rhyme?" Men activated an area on the left side of their brain, the inferior frontal gyrus, or Broca's area. When women did the same task, they indeed activated the left inferior frontal gyrus. But they activated the right as well. Equally interesting was that there was no difference in how quickly and accurately men and women could sound out nonsense words. This tells us that men and women can get the same result by perhaps using different routes.

Are different mental challenges involved in learning to read and reading to learn?

The so-called simple view states that reading has two major components: identifying the single word—— decoding—— and comprehending——understanding what we read. We now are able to examine the process of decoding in terms of brain organization. Comprehension is a lot more complicated. Obviously, to comprehend a printed word, we first have to decode it. But more is involved. We are studying that now.

What part of the brain is involved with processing meaning?

We speak of "this area of the brain" or "that area of the brain," but it's important to know that the brain is connected and that there are brain systems. These brain systems are forever communicating with one another. So even though for ease of communication we speak of specific areas, what we really have are networks that are communicating with one another constantly. Having said that, I will note that an area of the brain that particularly has to do with meaning is Wernicke's area, in the temporal lobe of the brain. The temporal lobes are located on each side of the brain just behind the ears. Teachers often find that some students can read and not understand a word whereas others can understand everything but have trouble decoding words.

How are those problems different?

Some children, particularly as they get older, reach a high level of accuracy in identifying words, but still have difficulty becoming fluent or automatic in their reading. They're very slow readers. And reading takes a great deal of energy. But those children or young adults can understand what they read. It just takes a lot out of them. It's very much an energy-consuming process. Other children may read words rapidly but may not get the meaning. Children with a serious problem called hyperlexia can decode very well, but they can't comprehend. It's the inverse of dyslexia. Dyslexic children have the lower-level phonologic deficit, but intact higher-order skills that allow them to comprehend at high levels. Children with hyperlexia have terrific phonologic skills but can't comprehend. Hyperlexia is a relatively rare disorder, and affected children often experience other difficulties as well. For all we know about the nature of reading, many misconceptions still exist about reading difficulties—— dyslexia, for example. One common misconception about dyslexia is that people see letters and words backward. That is unfortunate because I've seen many people for whom the diagnosis of dyslexia was delayed because they did not manifest reversal. People with dyslexia have no problem copying letters and words, and they don't copy words backward. They may make some reversals in writing but no more than other children do. They have difficulty naming things because dyslexia is a language difficulty, not a problem with visual perception. These children can copy the word correctly. For example, they can copy w-a-s for was and say the letters correctly. But when we ask them what word they copied, they say, "saw." So it's not a question of having the visual, perceptual skills but of what they do with a word on the page.

How do we bring the print to language?

Again, the brain mechanism of going from print to language is phonologically based. We have to transcode the print. We have to appreciate that the print stands for words that can be broken into smaller phonologic units and that the grapheme, the letter or the letter groups, represents these bits of language. When we look at print, we activate areas in the back of the brain that have to do with vision, convert the print to language by using areas farther forward in the brain that have to do with transcoding, and then use areas of the brain that get to the meaning of language. The important thing to remember is that although for ease of communication the system is described as linear, in fact, information is transmitted bidirectionally and in parallel. Educators are vitally interested in information that can help them teach reading. Many middle school and high school teachers, in particular, haven't been taught how to teach reading. I find it curious that teachers are often blamed for their students' poor reading. Of all the people to whom I lecture, the largest group, the most committed group, is teachers. They're the ones who want to know, "What do we know about reading? What can I take back to my classroom?" We haven't been able to provide teachers until recently with a knowledge base of what reading is all about. But fortunately, we——and when I say "we," I mean the whole scientific community that studies reading--now really understand the reading process from both cognitive and behavioral perspectives and, increasingly, from neurobiological perspectives. This evidence supports the fact that reading is part of language. To read, we have to break up spoken words into smaller units, understand that letters represent sounds, have a knowledge base, have a vocabulary, and have the motivation and enjoyment. Teachers now have a template, a scientifically based template, to guide them in how they teach reading. If they use this approach, they can actually make a difference.

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